What is claimed is:

1. An abnormal pattern candidate detecting apparatus comprising:

a linear structure extracting means for extracting a plurality of linear structures having different directionalities within a radiation image, based on image data representing the radiation image, by performing a linear structure extraction process;

a linear concentration calculating means for calculating linear concentrations of the extracted linear structures with respect to each pixel, which is assigned to be a pixel of interest, of the radiation image;

a directional distribution index calculating means for calculating indices of directional distribution of each of the extracted linear structures with respect to each of the pixels of interest; and

a candidate region detecting means for detecting candidate regions for tumor patterns within the radiation image, based on calculated evaluation values, obtained based on the linear concentrations and the indices of directional distribution, for each of the pixels of interest.

2. An abnormal pattern candidate detecting apparatus as defined in claim 1, wherein:

the candidate region detecting means detects a predetermined number of the positions of the pixels of interest having the highest evaluation values as the candidate regions.

3. An abnormal pattern candidate detecting apparatus as defined in claim 2, wherein:

the evaluation value is a product of the linear concentration and the index of directional distribution.

4. An abnormal pattern candidate detecting apparatus as defined in claim 3, wherein:

the indices of directional distribution (ent) are calculated by the following formula

$$ent = \sum_{i=0}^{n-1} \frac{Li}{total} \ln \frac{Li}{total}$$, wherein:

i represents a representative number that represents a category from among n categories (0 to n-1) into which inclinations of the linear structures in the vicinity of the pixel of interest are classified;

L_i represents a total length of the linear structures in the vicinity of the pixel of interest which are classified into the i category; and

total represents a total length of all of the linear structures in the vicinity of the pixel of interest.

5. An abnormal pattern candidate detecting apparatus as defined in claim 4, wherein:

the radiation image is a mammogram; and

the linear structure extraction process is a process that employs a morphology filter.

6. An abnormal pattern candidate detecting apparatus as defined in claim 5, wherein:

the linear concentration is derived by:

calculating the total sum of directional components toward the pixel of interest, of linear elements at points that construct the linear structures in the vicinity of the pixel of interest, weighted by the reciprocals of the distances between the pixel of interest and the points that construct the linear structures; and

normalizing the total sum thus obtained with a total sum of the lengths of the linear elements, weighted by the reciprocals of the distances between the pixel of interest and the points that construct the linear structures.

7. An abnormal pattern candidate detecting apparatus as defined in claim 3, wherein:

the radiation image is a mammogram; and

the linear structure extraction process is a process that employs a morphology filter.

8. An abnormal pattern candidate detecting apparatus as defined in claim 2, wherein:

the indices of directional distribution (ent) are calculated by the following formula

$ent = \sum_{i=0}^{n-1} \frac{Li}{total} \ln \frac{Li}{total}$, wherein:

i represents a representative number that represents a category from among n categories (0 to n-1) into which inclinations of the linear structures in the vicinity of the pixel of interest are classified;

L_i represents a total length of the linear structures in the vicinity of the pixel of interest which are classified into the i category; and

total represents a total length of all of the linear structures in the vicinity of the pixel of interest.

9. An abnormal pattern candidate detecting apparatus as defined in claim 1, wherein:

the evaluation value is a product of the linear concentration and the index of directional distribution.

10. An abnormal pattern candidate detecting apparatus as defined in claim 9, wherein:

the indices of directional distribution (ent) are calculated by the following formula

$ent = \sum_{i=0}^{n-1} \frac{Li}{total} \ln \frac{Li}{total}$, wherein:

i represents a representative number that represents a category from among n categories (0 to n-1) into which inclinations of the linear structures in the vicinity of the pixel of interest are classified;

L_i represents a total length of the linear structures in the vicinity of the pixel of interest which are classified into the i category; and

total represents a total length of all of the linear structures in the vicinity of the pixel of interest.

11. An abnormal pattern candidate detecting apparatus as defined in claim 1, wherein:

the indices of directional distribution (ent) are calculated by the following formula

$$ent = \sum_{i=0}^{n-1} \frac{Li}{total} \ln \frac{Li}{total}$$, wherein:

i represents a representative number that represents a category from among n categories (0 to n-1) into which inclinations of the linear structures in the vicinity of the pixel of interest are classified;

L_i represents a total length of the linear structures in the vicinity of the pixel of interest which are classified into the i category; and

total represents a total length of all of the linear structures in the vicinity of the pixel of interest.

12. An abnormal pattern candidate detecting apparatus comprising:

a core region detecting means for detecting a core region of a tumor pattern within a radiation image, based on image data representing the radiation image, by performing a predetermined detection process;

a linear structure extracting means for extracting a plurality of linear structures having different directionalities within the radiation image, by performing a linear structure extraction process;

a linear concentration calculating means for calculating linear concentrations of the extracted linear structures with respect to each pixel, which is assigned to be a pixel of interest,

of the radiation image;

a directional distribution index calculating means for calculating indices of directional distribution of each of the extracted linear structures with respect to each of the pixels of interest; and

an evaluating means for evaluating the degree of malignancy of the tumor pattern having the detected core region, based on an evaluation value, which is obtained based on the linear concentration and the indices of directional distribution, for each pixel of interest.

13. An abnormal pattern candidate detecting apparatus as defined in claim 12, wherein:

the evaluation value is a product of the linear concentration and the index of directional distribution.

14. An abnormal pattern candidate detecting apparatus as defined in claim 13, wherein:

the indices of directional distribution (ent) are calculated by the following formula

$ent = \sum_{i=0}^{n-1} \frac{Li}{total} \ln \frac{Li}{total}$, wherein:

i represents a representative number that represents a category from among n categories (0 to n-1) into which inclinations of the linear structures in the vicinity of the pixel of interest are classified;

L_i represents a total length of the linear structures in the vicinity of the pixel of interest which are classified into

the i category; and

total represents a total length of all of the linear structures in the vicinity of the pixel of interest.

15. An abnormal pattern candidate detecting apparatus as defined in claim 14, wherein:

the radiation image is a mammogram;

the detection process is a process that employs an iris filter; and

the linear structure extraction process is a process that employs a morphology filter.

16. An abnormal pattern candidate detecting apparatus as defined in claim 15, wherein:

the linear concentration is derived by:

calculating the total sum of directional components toward the pixel of interest, of linear elements at points that construct the linear structures in the vicinity of the pixel of interest, weighted by the reciprocals of the distances between the pixel of interest and the points that construct the linear structures; and

normalizing the total sum thus obtained with a total sum of the lengths of the linear elements, weighted by the reciprocals of the distances between the pixel of interest and the points that construct the linear structures.

17. An abnormal pattern candidate detecting apparatus as defined in claim 13, wherein:

the radiation image is a mammogram;

the detection process is a process that employs an iris filter; and

the linear structure extraction process is a process that employs a morphology filter.

18. An abnormal pattern candidate detecting apparatus as defined in claim 12, wherein:

the indices of directional distribution (ent) are calculated by the following formula

$ent = \sum_{i=0}^{n-1} \frac{Li}{total} \ln \frac{Li}{total}$, wherein:

i represents a representative number that represents a category from among n categories (0 to n-1) into which inclinations of the linear structures in the vicinity of the pixel of interest are classified;

L_i represents a total length of the linear structures in the vicinity of the pixel of interest which are classified into the i category; and

total represents a total length of all of the linear structures in the vicinity of the pixel of interest.